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STATEMENT OF

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BEFORE THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

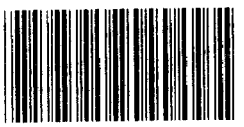
ON

THE [SPACE INDUSTRIALIZATION ACT OF 1980]

INTRODUCTION

Mr. Chairman, we are here today at your request to discuss the important issues of research and development, and the appropriate role for the Federal Government in fostering and enhancing technological transfer and innovation while maintaining the integrity of this nation's free enterprise system.

For a number of years the General Accounting Office has studied, reported to the Congress, given testimony, made speeches, and participated in countless discussions in public and private colloquia on the declining rates of productivity, innovation and general economic growth in the United States.



We have, among other issues, addressed the need for a workable mechanism to transfer and diffuse Government-developed technology to the private sector for innovation and exploitation. We have addressed the restrictive nature of certain regulations and policies on the innovation climate. Related to this we have seen the absolute requirements to raise venture or risk capital, without which innovation cannot occur. And, we have continually stressed the need for more and better cooperation among Government, industry, labor and academia.

Under consideration today is the Space Industrialization Act of 1980, which not only addresses some of these same issues, either directly or indirectly, but, conceptually, would provide a vehicle for at least partial solutions. There is a need to establish a strong national industrial policy in this country, a policy that would foster a steady stream of new, high technology business enterprises to provide new jobs, productivity increases, increased tax revenues and overall economic growth. As embodied in the purpose of the Act, and assuming its functions are appropriately laid out to complement rather than duplicate other ongoing or planned efforts, we fully support the concept of a government role in enhancing technological innovation as an American free enterprise answer to the highly coordinated programs of other industrialized nations like Japan and West Germany.

SPACE MANUFACTURING

I would like to begin by providing a brief discussion of a recently completed GAO study and report entitled "U.S. Must Spend More to Maintain Lead in Space Technology." This work was done at the request of the Senate Subcommittee on Science, Technology and Space, Committee on Commerce Science and Transportation. We had been asked to look into the near-term potential of manufacturing in space--near-term being defined as anytime between now and the year 2000.

Space manufacturing, as a concept, is the processing or making of materials in space by private enterprise which takes advantage of special properties achievable only in the unique environment of space, the most prominent component being constant near zero gravity.

NASA currently has a very small program effort which it calls materials processing in space or MPS program. This is a necessary initial step toward space manufacturing.

Some areas of experimentation so far include:

1. Vapor growth of single crystals to a size and degree of perfection never achieved on earth. This has the potential of expanding the capabilities and markets for the electronics and communications industries worldwide.

2. Homogeneity of materials melted and solidified to a degree not possible on earth. This suggests the potential for tremendous consistency, strength, and perfection in such materials as metlals, alloys and glasses.

3. Separation of live cells with improved resolution and purity. This could add a new dimension in the medical field for combatting disease.

4. Mixing materials with large density differences and maintaining the mix in suspension until solidification occurs. This has the potential of opening up new uses and new markets in the field of composite materials.

5. Melting and solidifying materials without contacting the walls of a container. This avoids contamination and nucleation effects which is a constant problem on earth in processing high-purity materials, such as vaccines and medicines.

6. Castings using only a thin oxide skin as a mold. The cost savings over current earth-bound methods of making cast and other kinds of molds could be substantial.

According to some materials scientists, enough of the right kinds of research could create a virtual knowledge explosion. The prospects of new discovery has captured the imagination and excitement of materials scientists throughout the industrial world, and have raised hopes of beneficial applications in metals and alloys, composite materials, glasses, semiconductors, biologicals, chemicals, and other items.

If these assessments are correct and the economics become favorable, the eventual national economic and social impact

could be enormous. One major benefit expected within the next 15 to 20 years is the ability of scientists to isolate and study complex phenomena in ways never possible before. At the very least, according to scientists, industrialists, and economists, this should improve earthbound products and processes.

SPACE INDUSTRIALIZATION

To put the current materials processing research program into proper perspective, let us touch upon the broader concept of space industrialization.

Space industrialization can be conceptualized as embracing three broad areas: Information, or information services; manufacturing; and energy. Common to each of these is the need for continuous research and development efforts to bring each area to maturity, and a space transportation system to launch and service current or future facilities that are or may become part of space industrialization.

If space industrialization is to fully mature, a wide range of opportunities must be identified which are unique to space, economically viable, and in which entrepreneurs, industries, and nations are willing to invest.

To date, only one--communications--meets this criteria. In length of time, satellite communications research began in the early 1960's. Earth observation services, such as that provided by Landsat, are maturing so that commercialization

is a viable prospect, but completion of the innovation process may yet require large infusions of capital resources.

By contrast, manufacturing and energy are both in very early stages of research.

This is why the National Research Council, industry, the scientific community and NASA are emphasizing basic research in MPS, rather than trying to identify specific products. This is simply recognition that there is a limit to how much the innovation process can be short-circuited to save time and cost. What often happens is that attempts to take short cuts end up taking more time and costing more money in the long run.

Several corollary observations can be made about the innovation process in space and on earth. First, the length of time on earth, from basic research to final marketing, varies considerably, but on average, business firms plan on about 5 to 8 years. Because of the uniqueness of space efforts, compared to earth-bound programs, we should expect to take more than 5 to 8 years to market new products or services from space, just as it has taken nearly 20 years for satellite communications to evolve. Thus, high expectations for quick returns are almost certain to be disappointing.

Second, in allocating resources, as a general observation, the nearer innovation is to fruition, the higher the likelihood it will be funded. In Government programs, for example, budget approval is often linked to measurable results, and in materials

in space we cannot measure results because we don't know what the results will be. Allocation of capital resources in the private sector is very similar.

Third, the number of scientists involved in basic research is relatively small, compared to those at other stages in the innovation process. Materials scientists involved in basic research in space are no exception, again suggesting that innovating new products, processes and services to the marketplace will be a slow process, because relatively few scientists are involved.

Finally, as new knowledge is gained and new ideas begin to evolve, there is an unfounded assumption that somehow this new knowledge, especially Government-funded research, mysteriously finds its way into the marketplace in the form of new products, processes or services. There are several critically important steps which must occur before innovation is complete. A better understanding of some of these steps, we believe, provides considerable insight into the widely publicized problem of the so-called slowdown in innovation in this country.

Let me illustrate, by hypothetical example, how we believe the innovation process could relate to the Space Industrialization Corporation. Let's assume that 2 or 3 bright scientists or engineers in an existing large company come up with a good idea for a new

product. The company, however, doesn't give the idea a high priority and the inventors decide to strike out on their own. (Hypothetical but not uncommon.)

They pool their resources, maybe get additional support from family and friends, and proceed to develop their invention. This form of capitalization, if they are lucky, may raise enough to produce a prototype of their product.

Once they have their product developed and are ready to start their operation they will need a fairly large infusion of capital to build and equip a small production facility to serve a small and probably local market. The capital requirement could range from several hundred thousand to several million dollars. They may seek bank loans, but since they are not yet producing and selling goods, there is little chance of obtaining such loans. Even if they could, this is short-term financing and the more they seek this type of arrangement, the worse their debt to equity ratio becomes. What they need is permanent capital, i.e., to sell equity. But the new firm, even though it may have been in existence for 3 to 5 years, has not developed sufficiently to attract investment bank or large institutional funds, and of course they are too young to make a public stock offering.

For the last several years, and especially during the decade of the 1970's, existing businesses have had to depend more and more on short term debt financing. One doesn't

have to look too far to realize the impact of this dependency on chance for success. During the last few months, for example, with interest rates reaching unprecedented levels, bankruptcies have been occurring at the highest rate since the early part of the depression. The current trend toward lower prime rates doesn't address the basic problem of businesses trying to operate successfully with short-term debt capital rather than equity capital. A positive feature of the SI Corporation concept is that equity capital would be available to promising business ventures.

One of the most severe problems in American money markets today is the inability of a new and developing company to acquire capital in its very early stages of development. Historically, venture capital companies have been instrumental in financing early development and start-up phases, but in recent years, they too have been reluctant to invest in early stages of business development. Conceptually, the Space Industrialization Corporation could fill much of this capital formation shortfall utilizing private sector criteria for their venture capital investments.

PRIVATE SECTOR CRITERIA IN VENTURE CAPITAL INVESTMENTS

Private venture capitalists require that business proposals meet very rigorous, but very essential criteria. These criteria are equally applicable to the Space Industrialization Corporation. For example, venture capitalists would want to know:

1. Whether the founders have a sound business plan which includes, among other things:

--technical feasibility of the product, process or service.

--assessment of the market size.

--assessment of pricing levels at which the product, process or service will sell.

--ability to produce within the assessed pricing levels.

--a strategic plan for market penetration.

--assessment of production efficiency, quality control, distribution, sales and marketing.

--assessment of capital needs for plant, equipment, and operating capital.

--assessment of continuing R&D capabilities.

2. They would want to know whether the founders possess the necessary level of talent and competency to operate a business enterprise successfully. (This is an extremely important criterion to the venture capitalists.)

3. They would want to know whether the prospective firm has the potential for steady growth and profitability toward a common goal of making a public stock offering. (To the venture capitalist, "going public" is the payoff. This is the point at which the venture capital firm sells its equity position in order to invest in other ventures.)

A number of events will now take place before the venture capitalist agrees to invest in the new business enterprise.

First, a team of specialized analysts will be hired. These are people who command fees of $1,000 to $1,500 each per day. These analysts, who are very scarce in private industry and all but non-existent in Government, will conduct a penetrating investigation of the business proposal to assess all the elements outlined above. This critical analysis typically shows the strengths and weaknesses of the business proposal. A common weakness is the absence of proven managerial competency among the originating founders. The reason, simply, is that inventors typically are scientists, not business managers.

As a hedge against the high risks the venture capitalists will face, they will want assurance that the new enterprise has sound talent to manage the organization. Quite often, they have leads to such talent.

The venture capitalist may now offer to provide the needed financing in exchange for an equity position in the new firm. The level of equity required depends largely on how much new talent will have to be brought into the firm, how much capital must be raised and how high the assessed risk is.

(Venture capitalists tell us that only about 1 or 2 percent of all proposals reviewed are actually funded, and of those that are funded, between 70 and 80 percent fail.)

Due to these kinds of uncertainties, a venture capitalist may require an equity position as much as 80 percent or more in

the firm. However, out of this, an equity position or attractive stock options will be offered to the additional managers needed in the new firm. Thus, the venture capitalist may end up with only a 10 to 20 percent equity ownership position.

Of course, giving up 80 percent of the prospective firm is a bitter pill for the founders to swallow. The venture capitalists' response to this is straight forward: If the venture is funded and is successful, the founders stand to gain 20 percent of potentially millions of dollars over time. If the venture is not funded, or if it is attempted in the wrong way and fails, the founders have 100 percent of nothing.

Of course, the scenario doesn't end here, but the point to be made is that, for various reasons, venture capitalists are finding it more and more difficult to justify investments in businesses at an early stage of development. This means fewer new high technology businesses are being spawned--fewer IBMs, Xeroxes, Texas Instruments--are appearing over the horizon.

The Space Industrialization Corportion is a venture capital company. The concept of enhancing and nurturing private enterprise activity with public funds is not new, but the Space Industrialization Corporation is unique in that it would provide early rounds of high risk capital--something the existing venture capitalists cannot afford to do. As the chairman of Intel Corportion said recently in an interview printed in the Harvard Business Review, "In America, there's

so little investment capital available that it's come to a situation where we pick the low hanging fruit and don't worry about planting new trees. We don't have resources available to do both."

BASIC PRINCIPLES TO BE FOLLOWED BY THE SPACE INDUSTRIALIZATION CORPORATION

If the Space Industrialization Corporation is to become a reality, there are at least three basic principles we believe should be followed if it is to succeed in its purpose.

(1) It should follow private sector criteria in selecting, analyzing, and investing in business opportunities;

(2) It should require coinvestments from private sources, but rarely, if ever, be the "lead" investor, i.e., the final decisionmaker; and

(3) Its goals should be clearly defined to include the transfer of existing Government-developed technology to the private sector as well as providing for the development and transfer of new technology.

Let me amplify the rationale for these three principles.

Private sector criteria

There are at least two strong reasons for adhering to private sector investment criteria. First, the pragmatic guidelines used by private venture capitalists attempt to maximize chances for success by assuring, as much as possible, that a prospective venture contains the essential elements of a sound proposal--a

sound business plan, a product, process or service that meets a public need, a market that can be satisfied within a price structure that is achievable, and capable management talent to carry out a business operation.

Despite these hard-nosed criteria, an estimated 70 to 80 percent of private sector ventures still fail. Because the Space Industrialization Corporation, by design, intends to invest in ventures at even earlier stages of business development than those currently funded by private venture capitalists, the failure rate is likely to be even higher. To relax these criteria is likely to raise the failure rate even further.

Secondly, it does not appear to be the intent of the Act to substitute corporation funds for bonafide R&D programs. Rather, its intent appears to be to enhance the rate of innovation of R&D results into new products, processes and services. To relax the investment criteria would tend to encourage the use of corporation resources to fund basic research.

As a corollary to this aspect, however, some of the failures that will occur may be due to insufficient basic research. This information should be provided to appropriate Federal R&D agencies to be incorporated into their research planning.

Coinvestments by private sources

Private sector venture capitalists with whom we have talked generally support the concept of coinvesting with a Federally sponsored venture capital entity. They recognize this as an

opportunity to spread their limited resources over a wider number of promising ventures. However, they emphatically reject this concept unless their own investment criteria are adhered to.

During the initial period of operation, the greatest probable danger to the Space Industrialization Corporation's success may be its propensity to invest in ventures that "sound" promising, but which fail to meet private sector criteria. The best test of whether a venture is sound, in our opinion, is that private funds are invested, and that the private investors make the final decision on whether to invest. One obvious reason is that private investors who put up their own money will make every effort to enhance success. They will tend to monitor progress closely and when a venture is unsuccessful, or the evidence is clear it will be unsuccessful, there will be little hesitancy in discontinuing the venture. Finally, the more private investors to show a willingness to invest in a venture, the higher the confidence that the investment decision is sound. It is common practice for venture capitalists to coinvest with each other. This not only leverages their risks, but it also provides multiple sources of judgments on the soundness of a venture.

Only in unusual circumstances, in our opinion, should the Space Industrialization Corporation make a unilateral decision to invest in a venture.

Transfer to Existing Government Developed Technology

As mentioned earlier, space industrialization is in its infancy. It seems unrealistic to expect enough sound business opportunities to evolve over the next 15 to 20 years within the space environment itself to justify the creation of the Space Industrialization Corporation. Chances for making profits would be extremely limited during this time due to the high cost, high risk nature of these longer term investments. Prospects of the Corporation itself going public under these circumstances would probably be nonexistent.

The success of the Space Industrialization Corporation, we believe, will depend on its ability to support sound business opportunities quickly after its inception, and to establish a profit-making track record as early as possible. This would add credence to the underlying concept in the Act and increase its chances of going public at an early date. And perhaps most important, the growing profits from successful ventures in early years could become a primary source of venture capital for future and more costly space industrialization endeavors, conceivably at little or no cost to the taxpayers.

This scenario suggests not only the approach which would have to be taken, but also some institutional problems that must be overcome.

There is good evidence that many potential business opportunities already exist, not only within NASA but other Federal R&D agencies as well.

A major problem that has always existed in the Federal sector is the lack of an effective mechanism for systematically analyzing and synthesizing available data to identify the most promising technologies for commercialization. There is no effort being given to "packaging" these technologies, including financial and market analysis, in a way that could enhance the transfer and innovation of government-developed technology.

This issue was addressed extensively in the Domestic Policy Review a year and a half ago. The Department of Commerce is now taking steps to improve technology transfer, as Dr. Baruch will discuss with you later.

Another part of this problem has been the relative obscurity of Federal technology to the private sector. You will hear testimony tomorrow on a continuing effort by the American Institute of Aeronautics and Astronautics to involve large nonaerospace firms in NASA-developed technology.

In addition to these efforts by Commerce and AIAA, there are others such as National Science Foundation's small business innovation programs, the Small Business Administration's SBIC program, and NASA's joint endeavors program.

In conclusion we fully support the concept of Federally assisted business development as an American free-enterprise

answer to Japan's Ministry of International Trade and Industry (MITI), but at the same time, we would not want to see unnecessary duplication at taxpayers expense. The Space Industrialization Act of 1980, if carefully designed and integrated into a well orchestrated Federal effort, could provide some of the answers this nation has been seeking.